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Sheet-like formed materialBACKGROUND OF THE INVENTION5 Cross reference to related applications

This is a national phase of International Patent Application No. PCT/JP2005/005475, with an international filing date of March 25, 2005. This application based upon and claims the benefit of priority from the prior Japanese Patent Applications No. 2004-124821, filed March 25, 2004, and  
10 No. 2004-133323, filed April 28, 2004 the entire contents of which are incorporated herein by reference.

Technical Field

[0001]

The present invention relates to sheet material with IC tags.

15 Description of the Related Art

[0002]

An example of a corrugated structure with IC tag labels adhesively attached is disclosed in US Patent No. 6,667,092. This conventional corrugated structure includes a second linerboard and a single-face flute  
20 that is comprised of a first linerboard and a corrugated medium. The IC tag labels are attached to one side of the second linerboard. Then the second linerboard is adhesively bound with the corrugated medium so that the IC tag labels are sandwiched between the second linerboard and the corrugated medium. In producing the corrugated structure with IC tags,  
25 the IC tags are handled in the form of IC tag labels. The IC tag labels are formed from a label sheet that includes a release liner, a label substrate, an

adhesive layer that is disposed on the bottom surface of the label substrate, and IC tags that is positioned on the upper surface of the label substrate. After the IC tags are attached to the adhesive layer, by making cutting line on label substrate and the adhesive layer so that cutting line surrounds IC tags, IC tag labels can be removed from the release liner. The IC tag labels are attached to the corrugated structure according to the following steps. First, the label sheet is unwound from a reel. The unwound label sheet is moved downstream between two rolls that are compressing the label sheet. At the same time, each IC tag label is exfoliated from the release liner and attached to the predetermined positions on one side of the second linerboard facing the corrugated board. The label sheet, after the IC tags are removed from it, is wound into a roll. The positions to attach IC tags are determined based on the marks on the second linerboard read by a sensor.

[0003]

The corrugator is a machine that has a large width (approximately two meters) and that is operated at high speed (200-300 meters per minute). One sheet of the sheet material is slit into several pieces in the cross direction. The same number of labelers as the number of the pieces is needed and the labelers need their own space. For making the space, the bulk corrugator, having a length of 100 meters or more, must undergo a large modification. The corrugator should preferably be operated at a constant laminating speed to keep the adhesive strength of corrugated board sheet and flatness of cut sheets. However, when the intermittent labeler disclosed in US Patent No. 6,667,092 is used without reducing the traveling speed of the second linerboard, mechanical troubles are likely to occur. Consequently, the IC tag may be attached to the sheet material

improperly or the IC tag may be damaged. This means that IC tag loss occurs frequently. As the IC tag is expensive (several tens yen/IC tag), such IC tag loss increases the production cost of corrugated board boxes with IC tags. Spending the high production cost is not acceptable because  
5 corrugated board products are characterized in its cheap cost.

#### SUMMARY OF INVENTION

[0005]

Considering the above-mentioned problems, one objective of the present invention is to provide sheet material including IC-tag tape coupled  
10 between its layers along their entire length.

[0006]

Said objective and other objectives as well as new features of the present invention will be more fully understood with reference to the following description and the accompanying drawings.

15 [0007]

In one embodiment of the present invention, an IC tag tape is attached to a sheet material. The IC tags (20) are attached to the IC-tag tape (30) with a constant pitch. The IC-tag tape is coupled between the laminated layers of the sheet material along their entire length.

20 [0008]

The term "IC tag" as used herein refers to an IC tag that includes an IC chip and an on-chip antenna. The on-chip antenna is enclosed inside the IC chip. The on-chip antenna is configured to receive a radio wave from an external radio antenna. The on-chip antenna then sends out the  
25 data to a processing unit. The term "IC tag" also refers to an IC tag with an inlet (i.e. a substrate film). In this embodiment, the IC tag as described

above is attached to an inlet. The term “IC tag” further refers to an IC tag with an external antenna attached from outside the tag. The term “IC tag” further refers to an IC tag formed by attaching the above-mentioned types of IC tag to a cover material such as laminate film. In the example above, 5 the IC tag can be replaced with a printed organic transistor. The term “IC tag” further refers to an IC tag formed by covering printed organic transistors with the cover material. The organic transistors are configured to function as a processor. The term “IC-tag tape” as used herein refers to a structure including an IC chip and a successively formed tape substrate. 10 The IC chip is attached to or formed on the tape substrate. The IC chip includes at least a radio processor having a logic/storage circuit and a radio antenna. The radio processor is configured to send out information to a processor without making contact with the processor.

[0009]

15 The tape substrate is ranged from 2 to 100 mm in width and preferably from 4 to 10 mm in width. The pitch of IC tags on the tape substrate may be a constant distance of 5-300 cm.

[0010]

The IC-tag tape, as it is, can be used as a cut tape, a sealing material, 20 a binding material, or a display material, or some other materials used for other purposes. The material of the tape substrate or other features of the IC-tag tape can be selected according to its use.

[0011]

Any configuration of a sheet material can be used in the present 25 invention as long as it is comprised of laminated sheets and an IC-tag tape that is attached between the laminated layers along their entire length.

The sheet material may be, for example, a corrugated board with the IC-tag tape, paper with the IC-tag tape, a synthetic resin sheet with the IC-tag tape, a synthetic resin film with the IC-tag tape, and other sheet material with the IC-tag tape. In the example of a corrugated board with the IC-tag  
5 tape, the IC-tag tape may be deployed between a single-face flute and a second linerboard or a first linerboard. The IC-tag tape may be inserted to any MD position (position in machine direction) in the corrugated board. In the example of paper including two or more layers, the IC-tag tape may be deployed between the layers. The IC-tag tape may be inserted to any  
10 position in the cross direction of the paper. The sheet material in this invention further includes packaging products made of the sheet material in addition to the above-mentioned sheet material.

[0012]

As described above, the present invention has the following  
15 advantages.

According to the invention of claim 1, in a case the sheet material having the IC-tag tape between its laminated layers along their entire length is a corrugated board, IC-tag tape is inserted between a single-face flute and a linerboard. Accordingly, the IC tag tape is held between the  
20 single-face flute and the linerboard and firmly fixed in a predetermined CD position (position in cross direction).

[0013]

Therefore, it is possible to prevent the IC-tag tape from dropping off the corrugated board during a process to form the corrugated board. It is  
25 also possible to prevent the IC tags from dropping off the corrugated board when it receives a vibration or a drop impact during the shipment. As the

IC tags are positioned inside the second linerboard, it is also possible to prevent the IC tags from being damaged even if the corrugated board becomes worn because of the friction between the boxes during the shipment.

5

## BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Hereinafter, the configurations of the IC-tag tape, the production method for a corrugated board with an IC-tag tape attached thereto, and the inspection method for a corrugated board with the IC-tag tape will be described as one embodiment of the present invention.

FIG. 1a is a perspective view of the IC-tag tape according to one embodiment of the present invention.

FIG. 1b is a perspective view of the IC-tag tape according to one embodiment of the present invention.

FIG. 2 is a perspective view of the IC-tag tape according to another embodiment of the present invention.

FIG. 3 is a cross section of the sheet material according to one embodiment of the present invention. The figure shows the schematic structure of one type of IC tag attached to the tape substrate.

FIG. 4 is a perspective view of the sheet material according to another embodiment of the present invention.

FIG. 5 is a perspective view of the sheet material according to another embodiment of the present invention.

FIG. 6 is a perspective view of the sheet material according to another embodiment of the present invention.

FIG. 7 is a schematic view of the production line for producing the sheet material using the production method according to one embodiment of the present invention.

FIG. 8 is a block diagram of the inspection part of the production  
5 line according to the present invention.

FIG. 9 is a view showing the layout of positions where the die cutter cuts the sheets into blanks and trims.

#### DETAILED DESCRIPTION OF THE INVENTION

10 [0014]

Fig. 1a and Fig. 1b show two typical configurations of an IC-tag tape (30). The term "IC (Integrated Circuit)" as used herein refers to an IC such as a silicon semiconductor as well as to an organic transistor formed by printing an electronic circuit or the like on a plastic film.

15 Fig. 1a shows an IC-tag tape (30) that includes a successively formed tape substrate (2) and IC tags (20). The IC tags (20) are attached to the tape substrate (2) with a constant interval. The tape substrate is ranged from 2 to 100 mm in width. This width of tape is suitable for attaching IC tags (20) to a corrugated board. The IC tags (20) may be comprised of an  
20 IC (3) (i.e. a chip covered with a protecting material) and an external antenna (4). The external antenna (4) is placed outside the IC (3) whereas an on-chip antenna is enclosed in the IC.

In the IC-tag tape (30) of Fig 1b, an IC tag (20) includes an IC (3), an antenna (4), and a substrate film (inlet) (5). The substrate film (5) is  
25 positioned between the antenna and the tape substrate (2). The IC (3) is placed on the antenna (4). In this embodiment, the tape substrate (2) of

the IC-tag tape (30) can be made of any material.

[0015]

Fig. 2 shows another embodiment of the IC-tag tape (30) where a cover material (6) (e.g. laminate film) is adhesively attached to the IC tags (20) so that the cover material can cover the IC tags (20) shown in Fig. 1a or Fig. 1b.

[0016]

In the two embodiments of IC-tag tape (30) as shown in Fig. 1a and Fig. 1b, the IC tags (20) are not covered with a cover material (6), so that they are exposed on the surface of the tape substrate (2).

The tape substrate (2) is made of, for example, a paper material, but may be made of any other material. A tape substrate (2) of paper material is easier to process than a tape substrate (2) of the other materials. For example, an antenna can be easily attached to the tape substrate (2) of paper material. As a result, the tape substrate (2) made of paper material is more cost effective than that of the other materials. Such paper material includes, for example, brown thin wrapping paper, which is 0.05 to 0.2 mm thick, kraft paper, and the like. In addition, regular paper with improved waterproofing can be used as such paper material. Such regular paper does not allow for liquid glue (alkaline glue) to soak into it.

The tape substrate (2) can be a plastic film. When organic transistors are printed on a plastic film, the plastic film can be used as an IC-tag tape (30). The plastic film with organic transistors is easy to be wound onto a paper core having a predetermined width. Thus, when the IC-tag tape (30) is the plastic film with organic transistors instead of IC chips, IC-tag tape reel (1) can easily be made (See Fig. 2).



[0017]

Fig. 3 shows a corrugated board as one embodiment of the sheet material with IC-tag tape according to the present invention.

Fig 3a shows a corrugated board (40) that includes a second  
5 linerboard (8), a corrugated medium (10), a first linerboard (9), and an  
IC-tag tape (30). The IC-tag tape (30) is coupled between the corrugated  
medium (10) and the second linerboard (8). The IC tags (20) on the IC tag  
tape (30) face the second linerboard (8). The IC-tag tape (30) as shown in  
Fig 1a or Fig 1b can be used in this embodiment. The adhesive  
10 surrounding each IC tag (20) prevents it from moving on/dropping off the  
surface of the tape substrate.

[0018]

Fig. 4 shows a paper book cover (70) and a paper band (71) wrapped  
around a book as one embodiment of the sheet material with an IC-tag tape  
15 (30). The book cover (70) and the paper band (71) are made of a paper  
material. In these examples, the IC-tag tape is embedded in the paper  
material. For example, the IC-tag tape may be positioned between the  
layers of the paper material. A piece of the book cover (70) or the paper  
band (71) can be torn off along the perforated line (72) and IC tag tape (30)  
20 is removed from the book cover (70) and the paper band (71). The IC-tag  
tape can be torn off along the perforated line (72).

In an alternative embodiment as shown in Fig. 5, the IC-tag tape  
can be placed on the spine of a hardcover book (73). Alternatively, the  
IC-tag tape (30) may form the bottom part of a packed bag (74), as shown in  
25 Fig. 6.

[0019]

Figs.7 to 9 show a production line for the corrugated board as shown in Fig. 3 according to one embodiment of the production method of the present invention.

In the production line (80), the first linerboard (9) is provided from a first linerboard roll (81) to a heater roll (82) with which the first linerboard (9) is heated. The material to be formed into the corrugated medium is provided from a corrugated medium roll (83) via a vaporizing or heater roll (84), a glue applicator (85) to a corrugating apparatus (86) where the material is corrugated into a corrugated medium. The first linerboard and the corrugated medium is attached together with a press belt (87). Then the first linerboard (9) and the corrugated medium (10) are adhesively attached to each other and are formed into a single-face flute (50). After that, the tips of flutes formed in the corrugated medium (10) of the single-face flute (50) are glued using the glue applicator (88). The glued single-face flute (50) then passes a bonding roll unit (91) that consists of an upper roll and a lower roll. The bonding roll unit (91) laminates the single-face flutes (50) and the second linerboard (8) that is provided from the second linerboard roll (89) via the heater roll (90). During this lamination, the IC-tag tape (30) is provided between the single-face flute (50) and the second linerboard (8) from an IC-tag tape reel. In this way, the first linerboard (8), the corrugated medium (10), the first linerboard (9), and the IC-tag tape (30) are adhesively attached to be formed into corrugated board (40). The corrugated board (40) is slit into a certain width by a slitter before it is cut with a cutter (94) into cut sheets (100) in which an IC-tag tape is embedded. The cutter (94) is controlled by the production control device (95) during the cutting process.

[0020]

When the production control device (95) activates the IC tags (20), a interrogator (reader/writer) (96) with an antenna detects the location of the IC tags (20) in the corrugated board (40) and sends location signals  
5 indicating the locations of the IC tags (20) to the production control device (95) (an interrogator as used herein refers to a reader/writer). The encoder (97) measures the feed length of the corrugated board in the machine direction that passes below the encoder (97) and sends signals indicating the length of the corrugated board to the production control device (95).  
10 The production control device (95) uses these signals to calculate the MD position of the IC tags (20) in the corrugated board (40). Based on the calculated result, the production control device (95) sorts the cut sheet (100) with an IC tag (20) as a non-defective sheet or as a defective sheet. The non-defective sheet is defined as a cut sheet (100) including an IC tag (20)  
15 within the area to be formed into a resultant corrugated board box while the defective sheet is defined as a cut sheet (100) including no IC tag within the area. The production control device (95) further sends out signals to a diverter for automatically removing the defective cut sheets from the production line.

20 [0021]

The method for producing corrugated board using the production line (corrugator) (80) is described below. When the single-face flute (50) and the second linerboard (8) are adhesively attached to each other, the IC-tag tape (30) is coupled between the corrugated medium (10) and the  
25 second linerboard (8). Preferably, the IC tags (20) on the IC-tag tape (30) face the second linerboard. Therefore the IC tags (20) do not make contact

with the starch paste that is automatically applied by the glue applicator to the tips of the flutes formed in the corrugated medium (10). The IC-tag tape (30) as embedded in the corrugated board then passes over heating platens of the corrugator. The heating platens contact the outer side of the second linerboard on which no IC tags (20) exists. The IC tags (20) are positioned on the inner side of the second linerboard. Therefore, the temperature of the IC tags (20) are kept under around 90° C. Accordingly, the performance of the IC tags (20) is not worsened.

[0022]

The single-face flute and the second linerboard are attached to each other using typical adhesives such as starch paste or vinyl acetate emulsion. Whether the typical adhesives can attach to the tape substrate (2) depends on the material of which the tape substrate (2) is made. If the tape substrate (2) is made of a material that is suitable for the attachment using the typical adhesives, the tape substrate (2) is attached to the corrugated medium (10). On the other hand if the tape substrate made of a material that is not suitable for the attachment using the typical adhesives, the tape substrate (2) is not attached to the corrugated medium (10). However, such adhesive does not exist on the interface between the IC-tag tape (30) and the second linerboard (8) in both cases. Therefore, the corrugated board (40) in both cases includes a dry streak, which may worsen the quality of the corrugated board. A statistic study on the quality management, however, has revealed that less than 5 mm of dry streak does not significantly reduce the compressive strength of the resultant corrugated board box. Therefore, even in the case that the tape substrate (2) is of plastic material, which does not stick to the above-mentioned adhesive, the resultant corrugated board

box can have a sufficient compressive strength.

[0023]

Typical equipment for inserting the IC-tag tape (30) between the single-face flute (10) and the second linerboard (8) includes a caster. The  
5    caster is placed in the aisle that is positioned on one side of the corrugator for allowing operators to operate the corrugator therefrom. A reel stand is placed on the caster. The reel stand includes an elongated bar extending across the corrugator. The elongated bar holds several reels of the IC-tag tape above the corrugator. The number of the reels is determined  
10    depending on how many number of pieces the corrugated board is slit into. The IC-tag tape is fed downwardly into the heating platens (92). The IC-tag tape (30) is then guided by a guide to the predetermined CD position in the corrugated board.

[0024]

15       If the IC tags (20) are positioned between the cover tape (6) made of laminate film and the tape substrate (2), IC tag tape (30) with sandwiched IC tags (20) is formed (Fig. 2). When the IC-tag tape (30) with the sandwiched IC-tag (20) is embedded in the corrugated board (40), both the tape cover and the liner board work for avoiding the damage on the surface  
20    of the IC tags (20).

      If certain adhesive is applied to the IC-tag tape (30) with the sandwiched IC-tags (20), the IC-tag tape (30) can be used as a cut tape with IC tags for corrugated board boxes (e.g. wraparound cases that are usually used for packaging beer cans). The cut tape is embedded around the  
25    wraparound case. By pulling the cut tape around the case, the wraparound case is opened and displayed.

[0025]

The cover tape (6) may be surface-treated to eliminate blocking in winding/unwinding process. The IC-tag tape (30) with the surface-treated cover tape (6) is easy to be wound onto a tape reel.

5 [0026]

When the IC-tag tape (30) with adhesive includes an organic transistor as an IC, it is possible to print an electronic circuit including an antenna directly on a tape substrate (2). The printed electronic circuit may be covered with a protecting coat. When the electronic circuit is covered with a protecting coat, cover tape (6) does not have to be used. If the tape substrate is strong enough for corrugator on-machine processing, an IC-tag tape having single layer structure as that of a cut tape can be formed by applying adhesive to one side of the tape substrate (2).

[0027]

15 A reel (1) of IC-tag tape (30) with adhesive is placed upstream of the cutter (94) of the corrugator. The IC-tag tape (30) is attached to a corrugated board. When the production line (80) ramps up, the corrugated board gains some acceleration. The production line (80) preferably includes a driving apparatus (not shown) to allow the feeding speed of the IC-tag tape (30) to follow the high speed of the corrugated board. By using the driving apparatus, excessive load exerted on the IC-tag tape can be avoided.

[0028]

25 The pitch of the IC tags (20) (IC-tag-pitch) on the IC-tag tape (30) is explained below. The IC-tag-pitch is determined according to the size of the resultant corrugated board box. Basically, the sheet material needs to

contain one IC tag in an area to be formed into one box. Thus, the IC-tag-pitch is generally determined by the length of the cut sheet (cut sheets are formed by cutting the sheet material into a desired length in the machine direction by the cutter). Various cut length is defined by the  
5 cutter (94) according to the desired types of boxes of customers. As more than one thousand different sizes of corrugated boxes are produced in one factory, the lengths of the cut sheets can be vastly various. Specifically, the sheet material is cut into more than 500 different lengths by the cutter (94). It is practically impossible to stock IC-tag tapes so that their IC-tag-pitches  
10 correspond to all the box sizes required by all of the customers. Therefore it is more practical to use IC-tag tapes (30) having a pitch of IC tags (20) that roughly corresponds to the desired length of the cut sheet (100). The IC-tag tape (30) with roughly adjusted IC-tag-pitch can be used for different types of products ordered by different customers. This allows for reducing  
15 the frequency of replacing a reel of IC-tag tape (30) with another reel to produce a different size of boxes.

[0029]

The IC-tag-pitch is determined according to the length of a corrugated board blank in the machine direction. The length of a blank in  
20 machine direction may be different depending on the type of corrugating rolls used in the factory or to the types of products ordered by customers. From G-flute corrugated boards, which have a flute depth of 1 mm, and from B-flute corrugated boards, which have a flute depth of 3 mm, comparatively small boxes (e.g. boxes for sweets) are produced. From A-flute corrugated  
25 boards and from double wall corrugated boards, comparatively large boxes (e.g. boxes for flowers and personal computers) are produced. Boxes for

business equipments and for furniture are also produced from double wall corrugated boards. Among middle sized boxes, an A-1 type box for packaging oranges or a television set has flaps on its upper surface. The A-1 type box (regular slotted box) is made from a corrugated board having a cut length of 1.2 m to 1.8 m in machine direction.

[0030]

On the other hand, a wraparound case is made from a cut sheet (100) having a comparatively short length (30-60 cm). When the length of the cut sheet (100) made into one case is short, the cutter (94) cuts the sheet material into twice or three times larger length than the length that is needed for one case. For larger boxes (A-1 type boxes), the sheet material made into one box has a length of 280 cm in the machine direction at most. Therefore, to attach one IC tag (20) to an area of corrugated board made into one box, the IC-tag-pitch should be 30 to 280 cm.

[0031]

For corrugated boards made from non-paper material, the IC-tag-pitch can be determined in a similar manner. In example of plastic corrugated board, the IC-tag tape is attached to the plastic corrugated board by putting the IC-tag tape into the corrugated board in a hot-melt state.

[0032]

The above described method for attaching an IC-tag tape (30) to sheet material can be applied to a packaging material other than those including layers laminated with air space between them like a corrugated board material. The IC-tag tape (30) can be applied, for example, to a laminated paper board to be formed into cartons (e.g. milk cartons). The laminated paper board is formed by laminating a sheet of paper and a sheet



of plastic film or by laminating several sets of the laminated sheets.

[0033]

Typical paper has a similar laminated structure to that of the laminated paper board. The lamination of the typical paper is formed by preparing pulp suspension (natural fibers suspended with water and other additives), flowing and dewatering the pulp suspension on a mesh net of a paper machine to form a wet web, combining several wet webs into a sheet, and then drying the sheet. During these steps, the IC-tag tape (30) is provided from a reel to a position between the wet webs running in the paper machine. The IC-tag-pitch of the IC-tag tape (30) is selected to be slightly shorter than the length of the final length of the resultant paper product so that at least one IC tag (20) is attached to the dried paper product. The tape substrate (2) in this embodiment is preferably made of thin paper that has a similar quality to the pulp to improve the bonding between the tape substrate (2) and the pulp. The IC-tag-pitch is determined according to the final length of the cut sheet that is specific to the resultant paper product (e.g. bond paper). The minimum IC-tag-pitch is about 5 cm.

[0034]

The IC tags (20) on the IC-tag tape (30) can be located in any MD position (position in the machine direction) in the corrugated board (40). In other words, IC-tag tape (30) is provided onto the corrugated board (40) without predetermining the MD position of the IC tag (20) with regard to the cutting edge of corrugated board (40). At least one IC tag (20) can be placed in any MD position within an area to be formed into one corrugated board box. The area is also defined by the cross direction length in

addition to the machine direction length. In practice, the CD position (position in the cross direction) of the IC-tag tape (30) on the corrugated board (40) is determined so that the IC-tag tape (30) will not be positioned in the trimmed part. When the IC-tag tape (30) having an IC-tag-pitch  
5 that is identical to the length of the cut sheet is not available, IC tag tape (30) having a similar IC-tag-pitch may be used. If the IC-tag-pitch is longer than the MD length of cut sheet (excluding the length of the trim), which is specific to the resultant product, cut sheet with no IC tag (20) is produced with a certain frequency. If the IC-tag-pitch is shorter than the  
10 MD length of the cut sheet, cut sheet with two or more IC tags (20) is produced with a certain frequency.

[0035]

Accepted difference between the IC-tag-pitch and the length of the cut sheet is determined by the loss accepted by the maker or according to  
15 the production schedule (the accepted difference is determined for both cases when the IC-tag-pitch is shorter than the length of the cut sheet and when the IC-tag-pitch is longer than the length of the cut sheet). The more the difference between the IC-tag-pitch and the length of the cut sheet (100) is, more frequently cut sheets (100) with no IC tag (20) are produced. The  
20 cut sheets (100) with no IC tag (20) are thrown away as defective sheets. Accordingly, when more cut sheets with no IC tag (20) are produced, the production loss becomes higher. A limit for the production loss is set by the maker. To reduce the defective sheets, it is necessary for the manufacturers to prepare IC-tag tape (30) of several tens of IC-tag-pitches  
25 based on orders from customers for various box products. The manufacturers choose one type of IC-tag tape (30) among the prepared IC

tag tapes (30) so that expected number of defective sheets will be below the predetermined loss limit.

[0036]

It is important to reduce loss of corrugated board (40) and of IC tags  
5 (20) in producing corrugated board boxes with an IC-tag tape (30) as well as  
to reduce the stock items in managing the stock of the IC-tag tapes (30).  
For example, if the cut length based on the customer's orders varies in a  
certain narrow range, it is useful to prepare one type of IC-tag tapes (30) so  
that maximum gap between the cut length and IC-tag-pitch will be 5 cm.  
10 If the cut sheet is 125 cm long and the IC-tag-pitch is 120 cm, which is  
shorter than the length of the cut sheet, then one cut sheet out of 25 cut  
sheets is configured to have two IC tags (20). In this case, 4 % of the cut  
sheets (100) and of IC-tag tape (30) are wasted. On the other hand, if the  
cut sheet is 125 cm long and the IC-tag-pitch is 130 cm, which is longer than  
15 the length of the cut sheet, then one cut sheet out of 26 cut sheets is  
configured to have no IC tag (20). In the latter case, less percentage of the  
cut sheets (100) and of the IC-tag tape (30) is wasted.

[0037]

However, by making an IC-tag-operation software to select one of  
20 the two IC tags (20) that are attached to one cut sheet (100), the cut sheet  
(100) with two IC tags (20) does not have to be sorted as a defective sheet.  
In this example, if cut sheets (100) with two IC tags (20) are accepted by a  
customer, the IC tag pitch of the IC-tag tape (30) is preferably set to be  
shorter than the length of the cut sheet (100) so that cut sheets (100) with  
25 no IC tag (20) are not produced. Consequently the loss of the cut sheets  
(100) is reduced. Further, if an IC-tag tape (30) having an appropriate

IC-tag-pitch is selectively used, and if the IC tag (20) is placed in a position that is not to be trimmed, the IC tag is not damaged during the die-cutting process. In other words, no defective cut sheets (100) with incorrectly positioned IC tags (20), no cut sheets (100) with two IC tags (20), or no cut  
5 sheets (100) with no IC tag (20) are produced. Therefore it is possible to reduce the need for removing such defective cut sheets after the die-cutting process.

[0038]

In some cases, cut sheets (100) with two IC tags must be sorted as  
10 defective sheets according to the desired types of boxes ordered by customers. If IC-tag-pitch of the IC-tag tape (30) is longer than the length of the cut sheet (100) for the desired type of the boxes, no cut sheets (100) with two IC tags (20) are produced but cut sheets (100) with no IC tag (20) are produced. Cut sheets (100) with no IC tag (20) must be rejected from  
15 the production line. On the other hand, if the IC-tag-pitch of the IC-tag tape (30) is shorter than the length of cut sheets (100), cut sheets (100) with two IC tags (20) are produced while cut sheets (100) with no IC tag (20) are not produced. The cut sheets (100) with two IC tags (20) must be rejected from the production line.

20 Thus, it is necessary to construct a system for removing the defective cut sheets (100) with no IC tag from the successively produced cut sheets (100).

[0039]

The inspection method for a corrugated board (40) with an IC-tag  
25 tape (30) is explained below. The easiest method is to use an interrogator (96) with a radio antenna that is positioned downstream of the cutter (94).

After being cut by the cutter (94), the cut sheets (100) pass a sensor.

For each cut sheet (100), the sensor starts generating the signals when the leading edge of the cut sheet (100) passes it and stops generating the signals when the tailing edge of the cut sheet passes it. If the a (96) detects a  
5 signal from one IC tag (20) while the sensor is generating the signals, the interrogator (96) sends out a signal for moving the cut sheet (100) to an auto stacker as a non-defective cut sheet (100). If the interrogator (96) detects no signals from IC tag (20) or detects signals from two IC tags (20) while the sensor is generating the signals, the cut sheet (100) is rejected from the  
10 production line as a defective cut sheet before the cut sheets are delivered to the auto stacker.

[0040]

In some examples, cut sheets (100) with two IC tags (20) are acceptable for customers. In these examples, if the interrogator (96)  
15 detects signals from one or two IC tags (20) that are attached to a cut sheet (100) while the sensor is generating signals indicating that one cut sheet (100) is passing the sensor, the cut sheet is sorted as non-defective and moved to the auto stacker that is used in the next process. By changing the rejecting criteria, inspection conditions may be adjusted so that a cut  
20 sheet (100) with two IC tags (20) is sorted as non-defective while a cut sheet (100) with three IC tags (20) is sorted as defective.

[0041]

Fig. 8 shows another inspection method using signals from an encoder (97). Typically, the production control device (95) stores previously  
25 calculated relative position between the encoder (97), the interrogator (96), and the cutter (94). The length of the cut sheets (100) is calculated using

the signals from the encoder (97) by the production control device (95). When the corrugated board (40) passes the interrogator (96), the interrogator (96) sends the IC tag (20) on the corrugated board (40) a signal for activating the IC tag (20). The IC tag (20) receives the signal from the  
5 interrogator (96) and sends back a signal to the interrogator (96). The interrogator (96) receives and passes the signal to the production control device (95). The production control device (95) uses this signal for identifying the MD position of the IC tag (20). Before the corrugated board (40) reaches the cutter (94), which is positioned downstream of the  
10 interrogator (96), the production control device (95) sends the cutter (94) a signal for ordering the cutter (94) to cut the corrugated board (40) into a predetermined length. Then the interrogator (96) detects the position of the IC tag (20) on the cut sheet (100) and sends the production control device (95) a signal indicating whether the IC tag (20) is exists on the cut  
15 sheet (100). The signal from the interrogator (96) is received by the production control device (95). If the signal indicates that the IC tag (20) is positioned within the area to be formed into a box, the production control device (95) sends an OK signal to a diverter as programmed. If the signal indicates that the IC tag (20) is positioned in the area to be trimmed, the  
20 production control device (95) sends a NG signal to the diverter as programmed.

[0042]

In this method, it is possible to detect defective cut sheets where the IC tag (20) is positioned in the area to be trimmed during the die cutting  
25 process or a process to form the cut sheet into a box (To form the cut sheet, the die cutting process and a gluing process are executed). Fig. 9 shows a

blank layout of a cut sheet (100) for wraparound cases. The die-cutter cuts the cut sheet (100) along the lines shown in Fig. 9. Fig. 9 also shows the positions of trim pieces (12). In the example shown, two blanks are positioned in a cut sheet (100) along the machine direction. Accordingly, 5 three trim pieces (12) are positioned in a cut sheet (100) along the machine direction. The production control device (95) calculates whether the IC tag (20) is positioned within the trim piece (12) using the trim data shown in Fig. 9 to determine whether the IC tag (20) is damaged by a die cutter during the process for forming the cut sheet (100) into a box. If the production control 10 device (95) determines that an IC tag (20) is positioned in an effective area (i.e. area to be formed into a resultant corrugated board box) of a cut sheet (100) and that the IC tag (20) is not damaged or cut, then the cut sheet (100) is sorted as non-defective and sent to the auto stacker used in the next process. Such inspection and management system using the production 15 control device (95) enables ensuring that an appropriate number of an IC tag or tags (20) are attached to a cut sheet (100).

[0043]

Each IC tag (20) occupies a small area on the cut sheet (100). If the cutting line intersects the small area, the IC tag (20) is damaged. 20 Consequently, a defective area (i.e. the area to be defined as trim area (12) by the die cutter) is set a little larger than the trim considering the size of the IC tag (20). The defective area may also be set a little larger considering the detection accuracy of the encoder (96). The IC tag (20) has a rectangular form that is defined by a first edge and a second edge that is 25 shorter than the first edge. If the IC tag (20) is usually positioned on the tape substrate (2) so that its first edge extends along the longitudinal

direction of the tape substrate (2) and to the machine direction in order to use a tape substrate (2) with a smaller width, the defective area should be set as a comparatively large area. On the other hand, if the IC tag (20) is positioned on the tape substrate (2) so that its second edge extends along  
5 the longitudinal direction of the tape substrate (2) and to the machine direction, the defective area can be set as a comparatively small area.

[0044]

Such calculation to figure out the defective area and for the production control device (95) to determine whether the cut sheet is  
10 defective or non-defective is carried out by sampling the signals from the interrogator (96) and from the encoder (97) for calculating the length of the cut sheet that has passed. The calculation may be performed after the cutting off process (i.e. process for cutting the sheet material into cut sheets having a predetermined length in the machine direction). However, it is  
15 comparatively difficult to avoid vibrating the cut sheets on a conveyer and to sample the accurate signals from the encoder (97).

[0045]

The production control device (95) sends a diverter (98) NG signals indicating the IC tag on a cut sheet is defective. The diverter (98) is  
20 configured to move upwardly and downwardly. The diverter (98) moves one end of the conveyer (99) downwardly and guides defective cut sheets below the conveyer (99) to reject the defective cut sheets from the production line. In this way, the defective cut sheets are accumulated in a stocker that is placed under the auto stacker. Existent system can be used  
25 for the process of rejecting defective sheets. Such existent system is used for rejecting excessively short cut sheets (100) that are produced while the



slitting dimension is changed to another dimension or for rejecting cut sheets (100) with a piece of silver paper or with a label that indicates the defective spot on the paper material of which corrugated board (40) is made.

These inspection methods enable not only detecting whether one or  
5 two IC tags (20) are positioned on a cut sheet of the corrugated board but also checking whether the IC tags (20) have a sufficient performance using the interrogator with a radio antenna. The performance of the IC tags (20) can be worsened by an external impact exerted while the IC tags (20) are attached to a cut sheet. This method serves for maintaining the quality of  
10 the products.

[0046]

The above-described method for rejecting defective cut sheets (100) of the corrugated board material with a defective IC tag (20) can be an effective inspection method and an effective quality assurance method for  
15 paper packages made of laminated paper. Such paper package is produced by unwinding the reeled laminated paper and then printing or die cutting the laminated paper.

Flat pieces of some plied sheet material with IC tags (e.g. a lamination of solid and flat paper board with flat plastic sheets or a  
20 lamination of plastic sheets) can be provided as raw material in a production line to check IC tag quality. In the example of cut sheets of such material, a defective cut sheet having a defective IC tag (20) is rejected from the production line during a folding and gluing process (i.e. a process for folding and applying glue on the cut sheet (100)), which is a final process  
25 after the die-cutting of the cut sheet (100). In this example, a series of cut sheets that are running at a high speed are inspected. When a CCD

camera detects one of the cut sheets is passing in front of it, the CCD camera sends a signal indicating that the cut sheet is passing. In the area that is detected by a CCD camera, the interrogator (96) detects the IC tag (20) by reading the signal from the IC tag (20) while the interrogator (96)  
5 sends to the production control device (95) a signal indicating that it received a signal from the IC tag (20). The production control device (95) then sends a signal to a rejecting device to make the rejecting device reject defective sheets or sends a signal to spraying device to make the spraying device spray ultraviolet fluorescent liquid to the defective cartons or cut  
10 sheets. When the interrogator with a radio antenna detects, for example, that no IC tag (20) is activating correctly on the inspected cut sheet (100) (e.g. the case the IC tag (20) on the cut sheet (100) is damaged or the case no IC tag (20) is attached to the cut sheet (100)) is including the case no IC tag (20) is attached to the cut sheet (100)), or that two IC tags (20) are attached  
15 on the cut sheet, the interrogator sends out a signal to the production control device (95). The production control device (95) then sends a signal to the rejecting device or to the spraying device. When these devices receive the commands, they reject the defective cartons or cut sheets or quickly spray ultraviolet fluorescent liquid to spraying the liquid.